Key Points

- Pre-operative imaging and case selection are critical for maximizing success.
- By fine tuning previously reported techniques in the literature, it is possible to completely extract equine cheek teeth with precision, control, and minimal damage to adjacent hard and soft tissue structures.
- Advanced drill skills and a thorough knowledge of equine dental and maxillofacial anatomy are necessary to perform these procedures successfully.
- Repulsion of mandibular cheek teeth without prior tooth preparation to weaken the periodontal ligament is discouraged due to the high risk of jaw fracture.
- Visualization and identification of dental structures is key to performing extraction cleanly.

Pathology associated with equine cheek teeth has been well documented by many research veterinarians and scientists from around the world. Dental fractures leading to significant crown loss and pulp exposure, apical infection, periodontal disease, dental malformation, supernumerary teeth, and maloccluded teeth are all potential pathologies that would necessitate extraction of a cheek tooth. Patient age and health, severity of disease, tooth positioning, severity of clinical signs, and owners financial and physical capabilities all play a role in determining if extraction is the best therapeutic option. Extraction of equine cheek teeth especially of those that are not already mobile is a demanding adventure for both horse and veterinarian, and it should be undertaken with serious thought, preparation, and conviction. Before attempting any extraction proper sedation, analgesia, visualization, equipment, and assistant help should be ready for use. The veterinarian undertaking the extraction should also be able to deal with any complication that arises as a result of the procedure however minor or major. With this in mind, only diplomates of the surgical and dental colleges, residents of specialty training programs, and general practitioners who have extensive training in dental and surgical techniques should perform the following extraction techniques.

In all published studies to date, intraoral extraction of teeth has provided the highest success rate and the lowest complication rate of any extraction technique; therefore, intraoral extraction of cheek teeth in the horse should always be considered prior to surgical extraction options. Alveolar bone plate removal via an extraoral approach is an excellent option for all mandibular cheek teeth where other extraction techniques would prove impossible or less ideal for the diseased tooth and horse. The modified repulsion technique discussed below works best for maxillary teeth positioned within the paranasal sinuses and maxillary premolar teeth. The pure fact that there are so many different approaches to the extraction of equine cheek teeth highlights the point that no one technique is perfect for every case, and the more techniques a practitioner becomes skilled with improves the possible outcome for the horse. Indications for surgical extraction are loss or severe damage to clinical crown, crown-root fractures, apical infection of young teeth, impacted teeth, open-mouth restriction, very small patient size, radicular/odontogenic cyst formation, crown-root ankylosis, hypercementosis of the reserve crown or roots, and dental malformation. An in-depth knowledge of equine maxillofacial and
dental anatomy is paramount to perform these surgical procedures successfully. These procedures are performed in as sterile a manner as possible.

Extraction of Mandibular Cheek Teeth via an Extraoral Approach to Alveolar Plate Removal

Prior to performing the extraction complete a thorough oral examination and perform any necessary additional intraoral treatments (e.g. occlusal adjustment for tooth over growth, reduction of enamel points). Preoperative radiographs need to be acquired to diagnose the appropriate tooth for extraction and examine regional and dental anatomy and pathology. Depending on the horse, tooth involved, pathology, and surgeon preference, the procedure may be performed under general anesthesia or standing with regional nerve blocks. A regional nerve block is performed for general anesthesia and standing procedures, and the surgical site is clipped and aseptically prepped. A small sterile marker or staple is used to mark the skin. The points marked on the skin are palpated intraorally and include:

- the junction of the buccal mucosa with the alveolar mucosa (vestibule) adjacent to the tooth to be extracted, and
- the clinical crown of the tooth to be extracted.

The site is appropriately draped. The skin incision is placed directly over the tooth to be extracted. The incision should NOT penetrate into the oral cavity and should always be located below the vestibule. If the tooth to be extracted is a mandibular premolar, a horizontal, curvilinear incision with its base oriented apically is created. The most ventral portion of the incision is placed directly over the reserve crown midway between the vestibule (previously marked) and the root apices of the tooth. If the tooth to be extracted is a mandibular molar, a vertical incision running in a dorsoventral direction is created. This incision will be slightly tilted in the rostrocaudal to caudoventral plane to mimic the angle of the molar tooth in the mandible. The incision runs from just ventral to the vestibule to the region of the root apices. The reason for centering the incision ventral to the vestibule is to avoid penetration into the oral cavity via the cheek. Be careful to avoid involvement of major regional anatomy (vessels, nerves, venous plexus, parotid duct, etc.) in the incision site.

Carefully dissect through regional anatomy in a routine fashion and provide hemostasis until the periosteum of the bone is encountered. Incise and elevate the periosteum. The Selden periosteal elevator is excellent for this task. The periosteum should be elevated from the root apices to the attached gingiva of the tooth to be extracted. When the elevator pushes up against the gingival margin, gently but firmly elevate the gingiva off the bone to allow access to the oral cavity. To elevate the gingiva cleanly (without tears) follow the curved contour of the alveolar crest to the clinical crown. The gingival opening is extended rostral and caudal so the mesial and distal aspects of the tooth to be extracted are visualized. This will allow for confirmation of the position of the diseased tooth.

Use the Hohman retractor to dorsally retract tissue and the Weitlaners to retract in the rostrocaudal direction. The alveolar bone plate overlying the diseased tooth should now be clearly visible. A high-speed surgical drill with a carbide bur and irrigation is used to carefully and precisely remove the alveolar bone plate. Work in a dorsal to ventral direction, and start at the clinical crown. Clearly expose the most mesial and distal aspects of the reserve crown by visualizing the mesial and distal periodontal ligament. ALWAYS LET THE TOOTH GUIDE THE DRILL. NEVER GUESS WHERE TO DRILL unless the tooth in question is embedded. In this case, radiographic guidance and confirmation is recommended prior to drilling. Suction is critical at this point for accurate drilling and visualization. Avoid drilling clinical crown, reserve
crown, and alveolar bone of adjacent teeth. If all structures are clearly visible, this should not be a problem. Remove the alveolar bone plate of the diseased tooth to the level of the furcation of the roots. In severely diseased teeth, this extensive removal of bone will most likely not be necessary. A mostly rectangular region of bone removal should result.

Section the diseased tooth. Using the drill, make a V-cut into the tooth from the clinical crown ventral to the furcation. The V allows for visualization at the bottom, lingual aspect, of the section. Do not cut past the lingual periodontal ligament. The periodontal ligament will appear as a bright red surface after cutting through white tooth. When drilling the clinical crown avoid cutting the tongue by ensuring its placement on the opposite side of the mouth. Once the tooth is sectioned longitudinally, test the tooth fragments for mobility with a little dental elevation. If no mobility is detected, section the tooth centrally in a rostral to caudal fashion. Now four fragments will be available for elevation.

Elevate the dental fragments. The dental elevators are used to elevate these fragments. If little progress is made gently and superficially drive a Mini Lambotte osteotome into the periodontal ligament space. This will cause the fragments to collapse into the alveolus with minimal force. Remove fragments from alveolus with small animal molar extraction forceps. Pull tooth fragments from alveolus with force in-line with alveolus. Do not lever the fragments in side-to-side direction as this may cause them to break (especially the roots). Thoroughly debride and flush the alveolus. Debride with caution in the region of the root apices as pathology may have exposed/involved the mandibular artery and nerve. Debride fistula if present. Smooth the bone margins with a round diamond bur (preferred) or carbide bur. Finish by taking and intra-operative radiograph to ensure all dental and pathologic material has been removed.

Place polyvinyl siloxane impression material in dorsal third of alveolus. Packing material is placed intraorally while the surgeon uses gauze packed into the surgical site to prevent material from migrating into the alveolus too ventrally. Packing material is molded flush to lateral bone margin and dorsal crestal bone. Gingiva should curl over edges of the packing material intraorally. Ensure no lipping of material outside of alveolus as this will lead to dislodging of the material. Remove all gauze. Close the surgical site in routine manner. In the majority of cases, no drain is placed. Apply a pressure wrap to minimize swelling and remove it in 1-2 days. Thoroughly rinse the oral cavity and recover the horse. Post-operative pain medication and antibiotics are provided as needed. Check the extraction site at days 2, 10, and 30 post-operatively to ensure packing remains in place and site is healing appropriately. Remove packing at 30-day recheck.

Extraction of Maxillary Cheek Teeth via Apical Trephine, Root Removal, and Repulsion

Prior to performing the extraction complete a thorough oral examination and perform any necessary additional intraoral treatments (e.g. occlusal adjustment for tooth over growth, reduction of enamel points). Preoperative radiographs need to be acquired to diagnose the appropriate tooth for extraction and examine regional and dental anatomy and pathology. With only rare exceptions, intraoral and surgical extraction of maxillary cheek teeth is performed standing with the horse receiving a constant rate infusion of a sedative. Regional and local nerve blocks are placed to provide anesthesia of the surgical site. The surgical site is clipped and aseptically prepped. If any portion of the clinical crown remains, molar spreaders and intraoral extraction forceps should be used to initiate the breakdown of the periodontal ligament. The amount of time spent on intraoral manipulation will vary tooth to tooth, but if radiographs have...
indicated a surgical procedure is necessary, then usually one hour maximum is sufficient. If intraoral extraction seems possible after initial manipulations, go for it!

A small sterile marker or staple is used to mark the skin. The points marked are:

- the junction of the buccal mucosa with the alveolar mucosa (vestibule) adjacent to the tooth to be extracted - palpated intraorally
- the clinical crown of the tooth to be extracted - palpatated intraorally
- the position of the roots of the tooth to be extracted – radiographic guidance

The site is appropriately draped. If the tooth involved is located in the rostral or caudal maxillary sinus, then an appropriate sinus flap is created. If the tooth to be extracted is located outside the maxillary sinus, then a skin incision is created in either a dorsoventral or rostrocaudal manner depending on pertinent regional anatomy. The skin incision is placed lateral to the tooth roots. The skin incision will be roughly 2-3 inches in length. Wide enough to accommodate a 1” inch trephine without soft tissue involvement. Be careful to avoid involvement of major regional anatomy (vessels, nerves, venous plexus, parotid duct, etc.) in the incision. Carefully dissect through anatomy in routine fashion providing hemostasis during progression until the periosteum of the bone is encountered. Incise and elevate the periosteum. The Selden periosteal elevator is excellent for this task. The periosteum should be elevated from the region of the roots and the soft tissue window large enough to accommodate the trephine. Use the Weitlaners to retract soft tissue.

The alveolar bone plate overlying the diseased tooth roots should now be clearly visible. Position the trephine over the roots and move the trephine in a clockwise direction with all teeth engaged to cut through the alveolar bone plate. The pneumatic drill can also be used at this point to create the 1 inch bone window. An osteotome or a hemostat can be used to remove the bone plate once the circumference is cut. Bone rongeurs or the drill can be used to carefully enlarge the trephine site at the edges if necessary. The alveolar bone removal should be large enough to expose both the mesiobuccal and distobuccal roots of the cheek tooth. The drill is used with irrigation and suction to cut through the two buccal roots at the crown-root junction. Once sectioned, elevators are used to dislodge the individual roots and extract them. ALWAYS LET THE TOOTH GUIDE THE DRILL. Suction is critical at this point for accurate drilling and visualization. Avoid drilling reserve crown, root, and alveolar bone of adjacent teeth. Once the buccal roots are removed, the palatal root can be visualized. Sectioning the palatal root at the crown-root junction is next, and this step can be VERY challenging. Go slow to avoid over drilling and keep dental structures clean and visual. When approaching the palatal aspect of the palatal root periodically check the root with dental elevators for movement. As soon as movement is achieved, stop drilling and elevate the palatal root.

Once all three roots are extracted, use the bur to create a flat working surface of remaining reserve crown. This flat surface will provide a solid platform to place the punch. Try to make sure mesial, distal, and buccal periodontal ligament is clear of overhanging bone. If the tooth is broken or diseased in a manner that will not allow for singular tooth repulsion, complete sectioning of tooth into 2-3 fragments for repulsion. Sectioning of the tooth in a vertical plane may necessitate the use of both the drill and osteotome. The osteotome can be used to propagate sectioning initiated by the drill in the vertical plane once the majority of the cut has been created. Once the reserve crown of the tooth is flat and well demarcated, a punch can be positioned on the flat surface. The punch is angled to deliver a force into the center of the tooth/alveolus or fragment. The punch should NOT be directed into the sidewall of an alveolus. An assistant should have a hand located intraorally to inform the surgeon of tooth/fragment mobility. The
surgeon using a small mallet delivers gentle taps to the punch until mobility of the tooth or fragments are achieved. If after multiple taps with a mallet the tooth is not mobile, punch placement should be rechecked. If the punch is positioned correctly and the tooth is not moving, either the tooth can be sectioned (if not already) and/or more of the reserve crown can be removed (young teeth). Sectioning the tooth in the vertical plane allows for use of the dental elevators and/or the Mini Lambotte osteotome to fatigue the periodontal ligament. The space created by the section within the center of the tooth allows for collapse/movement of the tooth fragment into this space once the periodontal ligament has been dislodged. When the tooth fragments becomes mobile, a gentle tap with a punch will deliver them intraorally so the assistant can remove the tooth digitally or with extraction forceps intraorally.

The full length of the alveolus is completely debrided with angled bone curettes and flushed copiously. Bone margins are smoothed with a round diamond bur (preferred) or carbide bur. If necessary, debride the sinus and treat appropriately. Take an intra-operative radiograph to ensure all dental and pathologic material has been removed. Place polyvinyl siloxane packing material in the coronal third of the alveolus. Packing material is placed intraorally while the surgeon uses gauze to prevent material from migrating into the alveolus too dorsally. Packing material is molded flush to crestal bone. Gingiva should curl over edges of packing intraorally. Ensure no lipping of the packing material outside of the alveolus into the sinus! Close the surgical site in routine manner. In the majority of cases, no drain is placed. Apply pressure wrap to minimize swelling. Remove the wrap in 1-2 days. Thoroughly rinse the oral cavity. Provide post-operative pain medication and antibiotics as needed. Check extraction site at days 2, 10, and 30 post-operatively. Remove packing at 30-day recheck.

The term buccotomy has been used to describe a variety of surgical procedures over the past four to five decades. The true definition of buccotomy is “a surgical incision through the cheek to gain access for an intraoral procedure.” The incisions described are not made into the cheek proper but the tissue overlying the alveolar bone, and the incision gains access to the mandibular and maxillary bone where the bulk of the procedure is performed. Entrance into the oral cavity is a secondary effect of the procedure, not the sole purpose for it. This distinction though minor is important as it changes the nature of significant adjacent regional anatomy and the need to provide as aseptic a working field as possible.

Multiple studies have been reported on the efficacy and complications associated with “a buccotomy.” All these studies should not be compared equally as the surgical technique in each paper is different in either major or minor ways; therefore, a discerning reader needs to closely read the materials and methods to know exactly what procedure is being reported on. A recent paper, does a very good job of summarizing the last 2 decades of research in this area.iii There have been two significant studies that have reported and evaluated the success of surgical procedures similar to the mandibular alveolar plate removal described. One study used a true buccotomy to intraorally elevate gingiva and alveolar mucosa to expose the alveolar bone plate, which was removed by chisel.3 The second utilized an approach similar to the one described in this lecture to access the alveolar bone plate and with fluoroscopic guidance locate the mesial and distal aspect of the tooth. An osteotome or bur was used to create a bone window onto the tooth, which was sectioned similarly. Apical fragments were elevated and coronal fragments were repulsed into the oral cavity.iv The main point of developing the technique above was to use the strengths of those procedures while improving upon their weaknesses. Though similar retrospective studies evaluating the surgical techniques described have not been published, cases
are being accumulated to produce such a study in the future. The main innovation provided by these techniques is the use of a drill to carefully and precisely remove the alveolar bone plate and/or section tooth roots and crowns with minimal to no trauma on adjacent teeth and minimal use of concussive forces.

Operative and post-operative complications encountered during these surgeries were osseous bleeding in the region of the root apices, temporary partial paralysis of the ipsilateral buccal nerve, surgical site infection, and displacement of the packing material. Osseous bleeding, though bothersome was never significant, and bleeding was easily controlled with the application of bone wax. Temporary paralysis of the buccal nerve was associated more with post-operative swelling than nerve damage during surgery. The lip was always checked for innervation and function following recovery from anesthesia/sedation. Prior to routine application of pressure wraps, it was found that partial paralysis would develop within 12-24 hours post-operatively. Use of the pressure wrap for 1-2 days following surgery drastically reduced the number of cases with this complication. All horses that developed lip paralysis secondary to swelling resolved within 1-6 weeks postoperatively. A small number of horses developed mild surgical site infections that were managed successfully with routine wound care and antibiotics. Finally, only two mandibular alveolar plugs displaced. One settled roughly 2 cm ventral to the alveolar ridge and the other was ejected into the oral cavity. Both were replaced with minimal effort and retained until removal. Additional possible complications not encountered by the author are laceration of the mandibular artery, destruction of major regional arteries, veins, and nerves, laceration of parotid duct, tongue laceration, mandibular fracture, maxillary fracture, damage to adjacent teeth, and displacement of packing into an irretrievable position. With good surgical techniques, experienced drill skills, careful planning, and patience the author believes all of these possible complications can be avoided.

In conclusion, surgical extraction of equine cheek teeth can be performed in a very precise, controlled manner that has the potential to reduce the number of operative complications experienced by surgeons and dentists in the past.

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